2010 Westward Region Salmon Forecast

Alaska Department of Fish and Game
Division of Commercial Fisheries
211 Mission Road
Kodiak, AK 99615

Forecast Area: Kodiak
Species: Pink Salmon

Preliminary Forecast of the 2010 Run

Total Production	Forecast Estimate (millions)	Forecast Range (millions)
KMA Wild Stock Total Run	9.2	7.9 – 10.8
KMA Escapement Goal	3.5	2.0 – 5.0
KMA Wild Stock Harvest	5.7	4.4 – 7.3
Kitoi Bay Hatchery Harvest[a]	5.7	4.1 – 7.2
Total KMA Pink Salmon Harvest	11.4	8.5 – 14.4

Note: Column numbers may not total or correspond exactly with numbers in text due to rounding.

[a] This figure is the total expected return (6.0 million) minus the broodstock collection goal of 350,000; the Kitoi Bay Hatchery cost recovery harvest is expected to be roughly 1.0–1.5 million

The 2010 KMA predicted pink salmon harvest is expected to be in the Weak to Average category with a point estimate of 11.4 million (8.5–14.4 million) combining the wild stock and Kitoi Bay Hatchery harvest estimates. Harvest categories were delimited from the 20th, 40th, 60th, and 80th percentiles of historical commercial harvest in the KMA from 1980 to 2009 and will be used to determine the length of initial fishing periods.

Total KMA Harvest Category	Range (millions)	Percentile
Poor	Less than 7.0	Less than 20th
Weak	7.0 to 10.6	21st to 40th
Average	10.6 to 15.2	41st to 60th
Strong	15.2 to 22.6	61st to 80th
Excellent	Greater than 22.6	81st to 100th

Forecast Methods

The KMA wild stock pink harvest forecast is derived from a total run forecast minus the mid-point (3.5 million) of the KMA escapement goal range. The total run estimates were derived from a combination of Karluk and Ayakulik weir counts, aerial survey indices, and harvest estimates.

For the 2010 KMA wild stock pink salmon forecast, a generalized Ricker model (Quinn and Deriso 1999[b]) was fit to the even-year KMA returns from 1980 to 2008 utilizing Karluk and Ayakulik rivers pink salmon escapement counts for the spawner index. Four additional terms were included in this generalized Ricker model: 1) KMA pink salmon indexed escapement (total escapement minus Karluk and Ayakulik escapement) of brood year, 2) November–February average air temperature anomalies, 3) November–February total precipitation divided by the variance (analogous to the Sharpe ratio) anomalies, and 4) June–July average air temperature anomalies (Figure G1).

[b] Quinn II, T. J. and R. B. Deriso. 1999. Quantitative fish dynamics. Oxford University Press. New York, NY.

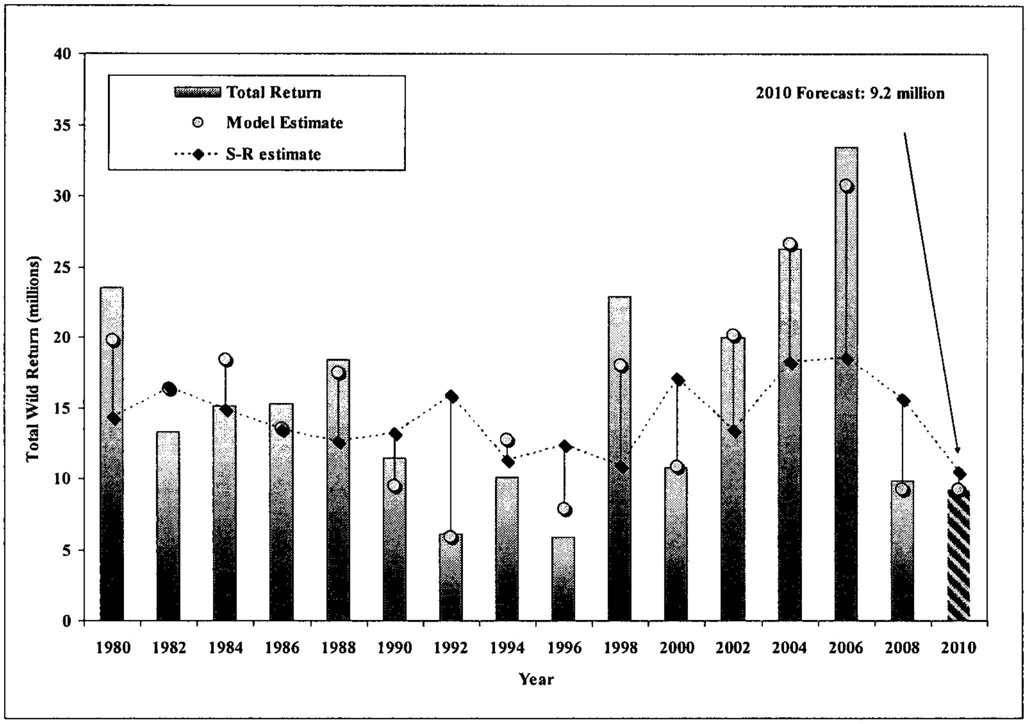

Figure E1.–Kodiak even-year pink salmon wild stock total return compared to spawner-recruit and generalized Ricker model (hindcast) estimates, from 1980 to 2008, and 2010 forecast.

This generalized model assumes that these environmental conditions affect the survival at early life history stages of pink salmon and thus were lagged to time of gravel residence (November–February) and near shore migration (June–July) of returning salmon. All environmental variables displayed a positive effect on total pink salmon return and the overall strength of the model was excellent ($R^2 = 0.93$; $P = 5.2 \times 10^{-5}$). Environmental conditions were estimated from Kodiak Airport (PADQ) climate observations. In constructing and evaluating the regression model, standard regression diagnostic procedures were used. Based on the generalized Ricker model, 80% prediction intervals were estimated.

The 2010 Kitoi Bay Hatchery pink salmon forecast was prepared by evaluating pink salmon survivals from even brood years 1994 through 2006, when releases from the facility were in excess of 100 million fry. Brood years 1996 through 2006 are particularly important to the forecasting model because all pink fry were released on the same day in order to saturate the release area with fry (predator satiation).This release strategy has proven to significantly improve fry to adult survival.

The pink return to Kitoi Bay Hatchery is an odd-year dominant return, but does experience an average strength even-year return every fourth year, which will occur in 2010. The total return estimate of 6.0 million reflects a marine survival of 3.88% and is an average of the previous 4 cyclical returns (2006, 2002, 1998 and 1994).

Forecast Discussion

The 2010 KMA wild stock pink salmon total run (9.2 million) will be below average but similar to 2008. Environmental conditions used in the model affecting the early life survival of the 2010 pink salmon run were below average but not as poor as those conditions affecting the 2008 return; however, the 2008 indexed pink salmon escapement estimate of 3.2 million is the lowest in the even-year time series back to 1980. The prediction of a Weak-Average wild stock total run is corroborated by ancillary information provided by the department's 2009 Arnie Shaul Memorial pink salmon fry abundance index estimated in Kodiak area harbors. Arnie Shaul worked as an Alaska Department of Fish and Game Area Management Biologist on the Alaska Peninsula from 1973 until 2005 and often predicted pink salmon abundance based on prior-year pink fry indices estimated in the nearshore waters. Confidence in the 2010 forecast estimate is good due to the strength of the wild stock model.

The 2010 Kitoi Bay Hatchery pink salmon production is expected to be 6.0 million. The broodstock collection goal is 350,000 million, resulting in a total hatchery harvest projection of about 5.7 million. The Kodiak Regional Aquaculture Association Board of Directors has yet to set a cost recovery goal for 2010, but it is estimated that 1.0–1.5 million will be harvested in the cost recovery fishery. In 2009, 153.7 million fry were released at an average size of 0.67 grams, which in terms of number of fry, was one of the largest in recent years. Saltwater temperatures trended cool early in the season and then increased rapidly later in the rearing period, which resulted in excellent fry growth despite a late emergence.

This forecast level should allow an initial weekly fishing period length of 57 hours (2½ days) for most of the KMA during the initial general pink salmon fisheries (beginning July 6, 2010). By the third week of July, fishing time likely will be restricted, by section or district, to ensure escapement goals will be met.

M. Birch Foster, Finfish Research Biologist, Kodiak
Drew Aro, Kitoi Bay Hatchery Manager, Afognak

Forecast Area: Kodiak, Spiridon Lake
Species: Sockeye Salmon

Preliminary Forecast of the 2010 Run

Total Production	Forecast Estimate (thousands)	Forecast Range (thousands)
Total Run Estimate	176	133–220
Escapement Goal	0	
Harvest Estimate	176	133–220

Forecast Methods

The 2010 Spiridon Lake sockeye forecast was prepared primarily by investigating simple linear regression models utilizing 1992–2007 outmigration-to-return relationships for 2 age classes. In constructing and evaluating each of the regression models, standard regression diagnostic procedures were used. Prediction estimates from regression models were only used in cases where the slope of the regression was significantly different from zero ($P < 0.25$). Age-2.2 ($R^2 = 0.89$; $P = 4.4 \times 10^{-8}$) fish were predicted from age-2 smolt outmigration abundance (1992–2007) and age-1.3 fish ($R^2 = 0.85$; $P = 0.009$) were predicted from age-1 smolt outmigration abundance (recent 6 years). Age-1.2 fish were predicted by the median percent return based on age-1 outmigration abundance during the last 6 years. All other age classes were estimated by summing the age classes (0.2, 1.1, 0.3, 2.1, 3.1, 1.4, 2.3 and 3.2) by return year (1996–2009) and calculating the pooled median contribution. The total run forecast was calculated by summing individual and median age class estimates. When the median return by age class was used, prediction intervals were estimated by calculating the 10th and 90th percentiles of the data. Using the variances of the regression models, 80% prediction intervals for the regression estimates were calculated. The overall 80% prediction intervals were calculated as the square root of the sum of the squared 80% prediction intervals for each age class forecasted.

Forecast Discussion

Sockeye salmon are prevented from returning to Spiridon Lake because barrier falls block upstream migrations in the outlet creek (Telrod Creek). Therefore, all returning adult sockeye salmon are available for harvest, primarily in the Central Section of the Northwest Kodiak District and in the Spiridon Bay SHA in Telrod Cove. The 2010 forecast (176,000) is 7,000 less than the 2009 forecast (183,000) and 21,000 more than the actual 2009 run estimate (155,000). The 2010 run should be composed of approximately 61% age-2.2 and 25% age-1.3 fish. Confidence in this forecast is good due to the strength of the regression models. If realized, this run will be about 70,000 less than the recent 10-year average (2000–2009) run of 247,000. The peak of the Spiridon Lake sockeye salmon run timing through the Westside fishery will be during the month of July.

M. Birch Foster, Finfish Research Biologists, Kodiak

Forecast Area: Kodiak, Ayakulik River
Species: Sockeye Salmon

Preliminary Forecast of the 2010 Run

Total Production	Forecast Estimate (thousands)	Forecast Range (thousands)
Total Run Estimate	670	478–862
Escapement Goal	250	200–500
Harvest Estimate	420	

Forecast Methods

The 2010 Ayakulik River sockeye salmon forecast was prepared primarily by investigating simple linear regression models utilizing outmigration year saltwater age class relationships. The Ayakulik sockeye salmon run tends to peak every 3 years (e.g., 2001, 2004, and 2007), thus only peak-year predictors were used in this year's forecast analysis. In constructing and evaluating each of the regression models, standard regression diagnostic procedures were used. Estimates from regression models were only used in cases where the slope of the regression was significantly different from zero ($P < 0.25$). Age-.2 sockeye salmon were predicted from prior year age-.1 returns ($R^2 = 0.85$; $P = 0.0009$) using only recent outmigration years (1990–2007). The age-.3 sockeye salmon were predicted from prior year age-.2 returns ($R^2 = 0.36$; $P = 0.09$) using outmigration years from 1980 to 2006. Using the variances of the regression models, 80% prediction intervals for the regression estimates were calculated. Both age-.1 and age-.4 sockeye salmon were predicted by calculating the median return (last 13 years) and prediction intervals were calculated using the 10th and 90th percentiles of the returns. Regression and median estimates were summed to estimate the total Ayakulik sockeye salmon run for 2010. The overall 80% prediction intervals were calculated as the square root of the sum of the squared 80% confidence intervals for each age class forecasted.

Forecast Discussion

The 2010 Ayakulik forecast (670,000) is 386,000 more than the 2009 forecast (284,000) and about 284,000 more than the actual 2009 run estimate of 386,000. The 2010 run should be composed of approximately 59% age-.2 and 39% age-.3 fish. If realized, this run will be 335,000 more than the recent 10-year average (2000–2009) and the largest since 1999. The Ayakulik sockeye salmon 3-year cycle of dominance historically has demonstrated roughly 70% stronger returns during peak years than other years; the 2010 run will represent the next peak in the cycle corroborating the strong forecast. The confidence in the 2010 Ayakulik forecast is good, due to the strong regression relationships. The projected harvest of 420,000 is based on the escapement of 250,000.

M. Birch Foster, Finfish Research Biologist, Kodiak

Forecast Area: Kodiak, Karluk Lake (Early Run)
Species: Sockeye Salmon

Preliminary Forecast of the 2010 Run

Total Production	Forecast Estimate (thousands)	Forecast Range (thousands)
Total Run Estimate	205	170–241
Escapement Goal	150	110–250
Harvest Estimate	55	

Forecast Methods

The 2010 Karluk Lake early-run sockeye salmon forecast was prepared by investigating one simple linear regression model and 3 Ricker curve relationships utilizing recent brood year (1979–2005) sibling relationships for 4 age groups. In constructing and evaluating each of the regression models, standard regression diagnostic procedures were used. The prediction estimate from the regression model was only used in cases where the slope of the regression was significantly different from zero ($P < 0.25$). Age-1.3 fish were predicted from age-1.2 siblings ($R^2 = 0.73$; $P > 1.1 \times 10^{-7}$). Age-2.3 fish were predicted using Ricker curves from age-2.2 siblings, and age-3.3 fish were predicted using Ricker curves from age-3.2 siblings. Age-.2 fish (ages 0.2, 1.2, 2.2, 3.2, and 4.2) were predicted using a Ricker curve from age-.1 fish (ages 1.1, 2.1, 3.1, and 4.1). All remaining age classes were estimated by summing 12 minor age class run estimates (ages 1.1, 0.3, 2.1, 0.4, 3.1, 1.4, 4.1, 2.4, 2.5, 3.4, 4.3 and 4.4) by year (1985–2009) and calculating the pooled median contribution. The total run forecast was calculated by summing individual and pooled age class estimates. When the median return by age class was used, the 80% prediction intervals were estimated by calculating the 10th and 90th percentiles of the data. Using the variances of the models, 80% prediction intervals for the regression and Ricker curve estimates were calculated. The overall 80% prediction intervals were calculated as the square root of the sum of the squared 80% prediction intervals for each age class forecasted.

Forecast Discussion

The 2010 forecast of 205,000 is about 99,000 more than the 2009 forecast (304,000) and about 136,000 more than the actual 2009 run estimate of 69,000. The 2010 run should be composed of approximately 75% age-.2 fish and 19% age-.3 fish. If realized, this run will be 311,000 less than the recent 10-year average (2000–2009) run of 516,000. The projected harvest of 55,000 is based on achievement of the mid-point of the escapement goal range (150,000). Age-2.2 fish were the dominant age class for 9 straight years prior to 2007 season and are historically the dominant age class. In 2009, all age classes returned a lower-than-expected levels. Most notably, the age-.2 fish returned at only one quarter of what was expected.

Due to the unanticipated extremely weak 2009 run, our confidence in this forecast is fair.

Mark Witteveen, Finfish Research Biologist, Kodiak

Forecast Area: Kodiak, Karluk Lake (Late Run)
Species: Sockeye Salmon

Preliminary Forecast of the 2010 Run

Total Production	Forecast Estimate (thousands)	Forecast Range (thousands)
Total Run Estimate	710	296–1,120
Escapement Goal	270	170–380
Harvest Estimate	440	

Forecast Methods

The 2010 Karluk Lake late-run sockeye salmon forecast was prepared by investigating simple linear and multiple regression models utilizing recent brood year (1980–2004) alternative sibling relationships, temperature indices, parent-year escapement, and calculating median returns. In constructing and evaluating each of the regression models, standard regression diagnostic procedures were used. Prediction estimates from regression models were only used in cases where the slope of the regression was significantly different from zero ($P < 0.25$). A significant alternative sibling regression relationship was employed to estimate the age-3.2 component of the run from age-2.2 sockeye salmon 2009 returns. A significant multiple regression relationship was employed to estimate the age-2.2 age class using a Kodiak summer air temperature index from 1986 to 2006 during the first summer of lake residence and the average of the parent-year escapement and escapement immediately prior to the parent year as predictors. Both the summer air temperature and parent-year escapement had a negative correlation with the age-2.2 returns ($R^2 = 0.62$; $P = 2.6 \times 10^{-4}$). A significant regression relationship was employed to estimate the age-.3 classes using a Kodiak summer air temperature index from 1980 to 2004 during the first summer of lake residence as a predictor. The age-.3 returns were also negatively correlated with summer temperature ($R^2 = 0.23$; $P = .01$). The age-3.2 fish were predicted from their age-2.2 siblings ($R^2 = 0.15$; $P = 0.06$). All remaining age classes were estimated by summing 13 minor age class run estimates (ages 0.1, 0.2, 1.1, 1.2, 2.1, 0.4, 3.1, 1.4, 2.4, 2.5, 4.2, and 3.4) by year (1989–2009) and calculating the pooled median contribution. The total run forecast was calculated by summing individual and pooled age class estimates. When the median return by age class was used, 80% prediction intervals were estimated by calculating the 10th and 90th percentiles of the data. Using the variances of the regression models, 80% prediction intervals for the regression estimates were calculated. The overall 80% prediction intervals were calculated as the square root of the sum of the squared 80% prediction intervals for each age class forecasted.

Forecast Discussion

The 2010 forecast of 710,000 is about 238,000 more than the 2009 forecast (472,000) and about 380,000 more than the actual 2009 run estimate of 330,000. The 2010 run should be composed of approximately 50% age-2.2, 24% age-3.2, and 22% age-.3 fish. If realized, this run will be 38,000 less than the recent 10-year average (2000–2009) of 749,000. The projected harvest of 440,000 is based on achievement of the mid point of the escapement goal range (270,000). Age-2.2 fish have been the dominant age class historically, but were in unexpectedly low abundance in 2006 through 2008 and extremely low in abundance in 2009.

This low abundance appears to be at least in part due to poor freshwater rearing conditions. The predictors for the 2010 age-2.2 component indicate a significant improvement, but poor freshwater growth will remain a significant factor and the 2010 age-2.2 forecast may be high. The higher-than-expected 2009 run of age-3.2 fish is further evidence of poor freshwater rearing conditions as what may normally have been age-2.2 fish reared in the lake an additional year and returned instead as age 3.2. Since there is rarely a negative relationship at Karluk Lake between the age-2.2 component in a given year and the subsequent age-3.2 fish the next year (as occurred in 2008/2009), our confidence in the 2010 predicted run of age-3.2 fish is fair. The Karluk late run continues to be difficult to forecast due to very few significant sibling relationships.

Mark Witteveen, Finfish Research Biologist, Kodiak

Forecast Area: Kodiak, Frazer Lake (Dog Salmon Creek)
Species: Sockeye Salmon

Preliminary Forecast of the 2010 Run

Total Production	Forecast Estimate (thousands)	Forecast Range (thousands)
Total Run Estimate	258	64–452
Escapement Goal	125	95–190
Harvest Estimate	133	

Forecast Methods

The 2010 Frazer Lake (Dog Salmon Creek) sockeye salmon forecast was prepared primarily by investigating simple linear regression models utilizing recent years (post Frazer Lake fertilization) saltwater age class relationships; however, mostly median estimates were used. In constructing and evaluating each of the regression models, standard regression diagnostic procedures were used. Estimates from regression models were only used in cases where the slope of the regression was significantly different from zero ($P < 0.25$). Age-.2 sockeye salmon were predicted from prior year age-.1 (jacks) returns ($R^2 = 0.78$; $P = 2.9 \times 10^{-5}$) using the 1994–2008 outmigration years. Using the variances of the regression models, 80% prediction intervals for the regression estimate were calculated. The age-.1, age-.3, and age-.4 sockeye salmon were predicted by calculating the median return (post-fertilization) and prediction intervals were calculated using the 10th and 90th percentiles of the returns. Regression and median estimates were summed to estimate the total Frazer sockeye salmon run for 2010. The overall 80% prediction intervals were calculated as the square root of the sum of the squared 80% confidence intervals for each age class forecasted.

Forecast Discussion

The 2010 Frazer Lake forecast of 258,000 is 143,000 less than the 2009 forecast (401,000) and about 217,000 less than the actual 2009 run estimate of 475,000. The 2010 run should be composed of approximately 55% age-.3 and 32% age-.2 fish. If realized, this run will be 126,000 less than the recent 10-year average (2000–2009) run of 384,000. Overall, the confidence in the 2010 Frazer Lake forecast is fair due to the number of median estimates used and large confidence interval. The projected harvest of 133,000 is based on the achievement of 125,000 through the Dog Salmon Creek weir. The targeted escapement is the Frazer Lake S_{MSY} estimate of 105,000 plus an additional 20,000 to account for the typical natural mortality (e.g., bear predation) occurring between the 2 weirs.

M. Birch Foster, Finfish Research Biologist, Kodiak

Forecast Area: Kodiak, Upper Station (Olga Lakes, Early Run)
Species: Sockeye Salmon

Preliminary Forecast of the 2009 Run

Total Production	Forecast Estimate (thousands)	Forecast Range (thousands)
Total Run Estimate	91	34–147
Escapement Goal	48	30–65
Harvest Estimate	43	

Forecast Methods

The 2010 Upper Station early-run sockeye salmon forecast was prepared primarily by investigating simple linear regression models utilizing recent outmigration year saltwater age class relationships. In constructing and evaluating each of the regression models, standard regression diagnostic procedures were used. Estimates from regression models were only used in cases where the slope of the regression was significantly different from zero ($P < 0.25$). Age-.2 sockeye salmon were predicted from prior year age-.1 returns ($R^2 = 0.56$; $P = 2.2 \times 10^{-4}$) using the 1989 to 2008 outmigration years. The age-.3 sockeye were predicted from prior year age-.2 returns ($R^2 = 0.42$; $P = 2.6 \times 10^{-3}$) using the 1988 to 2007 outmigration years. Using the variances of the regression models, 80% prediction intervals for the regression estimates were calculated. Both age-.1 and age-.4 sockeye salmon were predicted by calculating the median return (1990–2009) and prediction intervals were calculated using the 10th and 90th percentiles of the returns. Regression and median estimates were summed to estimate the total Upper Station sockeye salmon early run for 2010. The overall 80% prediction intervals were calculated as the square root of the sum of the squared 80% confidence intervals for each age class forecasted.

Forecast Discussion

The 2010 Upper Station early-run forecast of 91,000 sockeye salmon is 13,000 less than the 2009 forecast (104,000) and about 10,000 more than the actual 2009 run estimate of 81,000. The 2010 run should be composed of approximately 65% age-.2 and 31% age-.3 fish. If realized, this run will be 21,000 less than the recent 10-year average (2000–2009) run of 111,000. Overall, the confidence in the 2010 Upper Station early-run forecast is good; however, residual trends in the age-.2 predictor regression suggest the run will fall in the lower part of the range. The projected harvest of 43,000 is based on achievement of the mid-point (48,000) of the escapement goal range.

M. Birch Foster, Finfish Research Biologist, Kodiak

Forecast Area: Kodiak, Upper Station (Olga Lakes, Late Run)
Species: Sockeye Salmon

Preliminary Forecast of the 2010 Run

Total Production	Forecast Estimate (thousands)	Forecast Range (thousands)
Total Run Estimate	399	204–595
Escapement Goal	186	120–265
Harvest Estimate	213	

Forecast Methods

The 2010 Upper Station late-run sockeye salmon forecast was prepared primarily by investigating regression models utilizing recent outmigration year saltwater age class relationships. In constructing and evaluating each of the regression models, standard regression diagnostic procedures were used. Estimates from regression models were only used in cases where the slope of the regression was significantly different from zero ($P < 0.25$). Age-.2 sockeye salmon were predicted from prior year age-.1 returns ($R^2 = 0.62$; $P = 0.001$) using the 1995–2007 outmigration years assuming a Ricker relationship. The age-.3 sockeye were predicted from prior year age-.2 returns ($R^2 = 0.66$; $P = 7.6 \times 10^{-4}$) using the 1994–2006 outmigration years assuming a linear relationship. Using the variances of the regression models, 80% prediction intervals for the regression estimates were calculated. Both age-.1 and age-.4 sockeye salmon were predicted by calculating the median return (1996–2009) and prediction intervals were calculated using the 10th and 90th percentiles of the returns. Regression and median estimates were summed to estimate the total Upper Station sockeye salmon late run for 2010. The overall 80% prediction intervals were calculated as the square root of the sum of the squared 80% confidence intervals for each age class forecasted.

Forecast Discussion

The 2010 Upper Station late-run forecast of 399,000 is 72,000 more than the 2009 forecast (328,000) and about 50,000 more than the actual 2009 run estimate of 349,000. The 2010 run should be composed mostly of age-.2 fish (86%). If realized, this run will be 100,000 more than the recent 10-year average (2000–2009) run of 300,000. Overall, the confidence in the 2010 Upper Station late-run forecast is good due to the strength of the age-.2 sockeye relationship which comprises the majority of the run. The projected harvest of 213,000 fish is based on the achievement of the S_{MSY} estimate (186,000).

M. Birch Foster, Finfish Research Biologist, Kodiak

Forecast Area: Chignik
Species: Sockeye Salmon

Preliminary Forecast of the 2010 Run

Total Production		Forecast Estimate (thousands)	Forecast Range (thousands)
Early Run (Black Lake)	Total Run Estimate	1,080	373–1,790
	Escapement Goal	350	350–400
	Harvest Estimate[a]	730	
Late Run (Chignik Lake)	Total Run Estimate	1,110	646–1,570
	Escapement Objective[b]	250	250–400
	Harvest Estimate[a]	857	
Total Chignik System	Total Run Estimate	2,190	1,019–3,360
	Escapement Objective[b]	600	600–800
	Harvest Estimate[a]	1,590	

Note: Column numbers may not total or correspond exactly with numbers in text due to rounding.

[a] These figures include harvests of Chignik-bound sockeye salmon from the Southeastern District Mainland and the Cape Igvak fisheries; approximately 1.3 million sockeye salmon are projected to be harvested in the Chignik Management Area.

[b] The Chignik Lake late-run escapement goal is 200,000–400,000, resulting in an escapement goal for the entire run of 550,000–800,000. However, managers try to achieve an additional inriver run goal of 50,000 in August and September.

Forecast Methods

The forecasts for the 2010 early and late Chignik sockeye salmon runs were based on available data from 1977 to the present. Simple linear regressions were modeled using recent outmigration year saltwater age class relationships. Each regression model was assessed with standard regression diagnostic procedures. Regression estimates were only used in cases where the slope of the regression was significantly different from zero ($P < 0.25$). The variance of each estimate was calculated from the error structure of the regression. Regression analyses were examined for serial autocorrelation.

The predicted 2010 early-run age-.3 (ages 0.3, 1.3, 2.3, 3.3, and 4.3) sockeye returns were estimated based on the abundance of prior age-.2 (ages 0.2, 1.2, 2.2, and 3.2; $R^2 = 0.55$; $P = 1.6 \times 10^{-5}$). Following non-significant regression results, the early-run age-.1 (ages 0.1, 1.1, 2.1 and 3.1), age-.2 (ages 0.2, 1.2, 2.2, and 3.2), age-.4 (ages 0.4, 1.4, 2.4, and 3.4), and age-.5 (age-1.5 and age-2.5 fish) components were predicted by calculating the median returns since 1981 outmigration year. Saltwater age class and cumulative precipitation relationships were analyzed for the late-run forecast. The age-.2 sockeye salmon were predicted from prior year's age-.1 returns using simple linear regression, ($R^2 = 0.42$; $P = 2.6 \times 10^{-4}$). Returns of age-.3 sockeye salmon were predicted from an index of total cumulative winter precipitation. The age-.3 sockeye returns were negatively correlated with winter precipitation ($R^2 = 0.27$; $P = 0.02$). The summation of precipitation data from October through April of the winter prior to the outmigration year were obtained from the Cold Bay Airport climate database. The age-.4 sockeye salmon were predicted from age-.3 returns using simple linear regression ($R^2 = 0.13$; $P = 0.08$). The age-.1 and age-.5 sockeye age classes were predicted by calculating the median returns.

The variances associated with individual regression estimates by age class were used to calculate 80% prediction intervals for those estimates. Prediction intervals were re-estimated utilizing the standard error from a regression of the residuals when serial autocorrelation was detected. Prediction intervals for median estimates were calculated using the 10th and 90th percentiles of the returns. For each run (early and late), the overall 80% prediction intervals were calculated as the square root of the sum of the squared 80% prediction intervals for each forecasted age class. The early- and late-run regression and median estimates were summed to estimate the total Chignik watershed sockeye salmon run for 2010. The combined early- and late-run 80% prediction interval was calculated by summing the lower prediction bounds and upper prediction bounds of the 2 runs.

Forecast Discussion

The 2010 sockeye salmon run to the Chignik River is expected to be approximately 2.19 million. The early run is expected to be approximately 1.08 million. The late run is expected to be approximately 1.11 million. The 2010 Chignik sockeye salmon run is expected to be approximately 158,000 more than the recent 10-year average run (2.03 million) and 90,000 more than the 2009 run (2.10 million).

The projected harvest estimate for the early run of 730,000 is based on achievement of the lower end of the early-run escapement goal range of 350,000. The projected harvest estimate for the late run of 857,000 is based on achievement of the lower end of the late-run inriver run goal range through September 15 (250,000). Harvest estimates for the both runs include Chignik-bound sockeye salmon harvested in the Cape Igvak Section of the Kodiak Management Area and the Southeastern District Mainland of the Alaska Peninsula Management Area.

Available smolt data were analyzed and a significant simple linear regression relationship (R^2 = 0.62; P = 0.002) was found using the number of outmigrating age-2. smolt to predict the subsequent age-.3 adult returns (about 82% of the run). This estimate was then expanded proportionally to account for other ages (age-.1, -.2, -.4, and age-.5). The smolt-based forecast of the 2010 Chignik total sockeye salmon run is 1.54 million, which is less (700,000) than that predicted from ocean-age relationships and median estimates (2.19 million).

The smolt forecast approximates the median and ocean-age class forecasts. Given this ancillary information, our confidence in this forecast is fair.

Heather Finkle, Finfish Research Biologist, Alaska Peninsula

Forecast Area: Alaska Peninsula, Bear Lake (Late Run)
Species: Sockeye Salmon

Preliminary Forecast of the 2010 Run

Total Production	Forecast Estimate (thousands)	Forecast Range (thousands)
Total Run Estimate	423	232–613
Escapement Goal	117	117–195
Harvest Estimate	306	

Forecast Methods

The 2010 Bear River late-run sockeye salmon forecast was prepared using regression and median estimates and investigating simple linear regression models of saltwater age class relationships with data from the past 19 years. In constructing and evaluating the regression models, standard regression diagnostics were used. Prediction estimates from regression models were only used in cases where the slope of the regression was significantly different from zero ($P < 0.25$). The age-.3 sockeye salmon returns were predicted from the previous year age-.2 returns using simple linear regression ($R^2 = 0.36$; $P = 9.1 \times 10^{-3}$). Returns of age-.2 sockeye salmon were predicted using multiple regression from an index of a 4-year average of winter (January through April and October through December) air temperatures that encompassed temperatures from the year of outmigration and the 3 years prior to the outmigration and the total inches of October precipitation from the year of outmigration ($R^2 = 0.47$; $P = 6.0 \times 10^{-3}$). The age-.2 sockeye salmon returns were positively correlated with air temperature; however, they were negatively correlated with October precipitation. Air temperature and precipitation data were obtained from the Cold Bay Airport climate database. Estimates of variance were calculated from the regressions. The remaining sockeye salmon age-.1 and age-.4 returns were predicted from median estimates for each of the age class run estimates using data from the last 15 years. The total run forecast was calculated by summing individual regression and median age class estimates. When the median return by ocean age was used, the 80% prediction intervals were estimated by calculating the 10th and 90th percentiles of the data. Using the variances estimated from the model, 80% prediction intervals were calculated for the regression model. The overall 80% prediction interval was calculated as the square root of the sum of the squared 80% prediction intervals for each age class forecasted.

Forecast Discussion

The 2010 Bear Lake late-run forecast of 423,000 sockeye salmon is about 369,000 less than the 2009 forecast (792,000) but about 118,000 more than the actual 2009 run of 304,000. The 2010 run should be composed of approximately 71% age-.2 and 24% age-.3 fish. If realized, this run will be 109,000 less than the recent (2000–2009) 10-year average (532,000). On average, age-.2 sockeye salmon comprise about 63% of the Bear Lake late run. The projected harvest of 306,000 is based on the achievement of the lower bound of the escapement goal range (117,000). Because the uncertainty associated with the variable predictive capabilities of the sibling data, our confidence in this forecast is fair.

Heather Finkle, Finfish Research Biologist, Alaska Peninsula

Forecast Area: Alaska Peninsula, Nelson River
Species: Sockeye Salmon

Preliminary Forecast of the 2010 Run

Total Production	Forecast Estimate (thousands)	Forecast Range (thousands)
Total Run Estimate	492	295–689
Escapement Goal	150	97–219
Harvest Estimate	342	

Forecast Methods

The 2010 Nelson River sockeye forecast was prepared primarily by investigating simple linear regression models of saltwater age class relationships and temperature and precipitation data from the past 22 years. The precipitation indices were constructed from the total May precipitation measured at the King Salmon Airport in the year prior to outmigration starting in 1985 and annual average summer (May–September) air temperatures from the Cold Bay Airport for corresponding outmigration years, starting in 1986. In constructing and evaluating each of the regression models, standard regression diagnostics were used. Prediction estimates from regression models were only used in cases where the slope of the regression was significantly different from zero ($P < 0.25$). The age-.2 sockeye salmon returns were predicted from the King Salmon May total precipitation index in the year prior to outmigration using simple linear regression. The age-.2 sockeye salmon returns were negatively correlated with May precipitation ($R^2 = 0.28$; $P = 1.1 \times 10^{-2}$). The age-.3 sockeye returns were predicted by linear regression of the ratio between age-.3 and age-.2 fish (same outmigration year) on the annual average summer air temperature index. The age-.3 sockeye returns were negatively correlated with the average summer air temperature ($R^2 = 0.34$; $P = 5.9 \times 10^{-3}$). Estimates of variance were calculated from each regression. The remaining age-.1 and age-.4 returns were calculated from the median estimates for each of the age class run estimates using data from 1989 to the present. The total run forecast was calculated by summing individual regression and pooled age class estimates. When the median return by age was used, the 80% prediction intervals were estimated by calculating the 10th and 90th percentiles of the data. Using the variances of the regression models, 80% prediction intervals for the regression estimates were calculated. The overall 80% prediction intervals were calculated as the square root of the sum of the squared 80% prediction intervals for each age class forecasted.

Forecast Discussion

The 2010 Nelson River forecast of 492,000 is about 72,000 more than the 2009 forecast (420,000) and about 121,000 more than the actual 2009 run of 371,000. The 2010 Nelson River sockeye salmon run is expected to be 50,000 less than the recent 10-year average run (543,000). The 2010 run should be composed of approximately 65% age-.2 and 33% age-.3 fish. Since the regression relationships predicting age-.2 and age-.3 sockeye are significant and represent a vast majority of the run, the confidence in this forecast is fair. The projected harvest of 342,000 is based on the achievement of the approximate midpoint of the escapement goal range (150,000).

Heather Finkle, Finfish Research Biologist, Alaska Peninsula